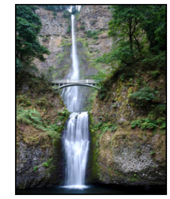
Journal of Environmental Psychology 59 (2018) 107–110

Contents lists available at ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep



Perceptions of scientific consensus do not predict later beliefs about the reality of climate change: A test of the gateway belief model using cross-lagged panel analysis

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ARTICLE INFO

Handling editor: Jeff Joireman

Keywords:
Scientific consensus
Climate change
Gateway belief model
Attitude change

ABSTRACT

The gateway belief model posits that perceptions of scientific agreement play a causal role in shaping beliefs about the existence of anthropogenic climate change. However, experimental support for the model is mixed. The current study takes a longitudinal approach, examining the causal relationships between perceived consensus and beliefs. Perceptions of scientific consensus and personal beliefs about climate change were collected over a five-month period in a student sample ($N = 356$). Cross-lagged panel analysis revealed that perceived scientific consensus did not prospectively predict personal agreement with the reality of climate change, thus the current study did not find support for the gateway belief model. However, the inverse pathway was significant for those with liberal voting intentions: personal beliefs about the reality of anthropogenic climate change prospectively predicted subsequent estimates of consensus. The results suggest that individuals' perceptions of a consensus among scientists do not have a strong influence on their personal beliefs about climate change.

1. Introduction

Many people around the world reject the reality of anthropogenic climate change (ACC), despite an estimated 97% of climate scientists agreeing that climate change is both occurring and caused by human activity (Tranter & Booth, 2015). A lack of public certainty regarding the reality of ACC can lead to delays in action to mitigate the future effects of climate change, resulting in worse environmental and economic outcomes in the long term (Gifford, 2011; IPCC, 2014). One proposed target for increasing public acceptance of ACC is perceptions of scientific consensus (Maibach & van der Linden, 2016). Within models of persuasion such as the elaboration likelihood model (Petty & Cacioppo, 1986), heuristics such as consensus information ('consensus implies correctness') and source credibility ('experts can be trusted') are used to guide attitude formation. In this regard, perceptions of an expert consensus could be assumed to influence personal beliefs. In line with such assumptions, cross-sectional research has shown that perception of agreement among climate scientists is correlated with personal agreement that ACC is occurring (Ding, Maibach, Zhao, Roser-Renouf, & Leiserowitz, 2011; Hornsey, Harris, Bain, & Fielding, 2016).

The idea that changes in perceptions of consensus can *cause* changes in personal acceptance of ACC is captured in the gateway belief model (van der Linden, Leiserowitz, Feinberg, & Maibach, 2015). The model posits that the perception of a consensus among scientists acts as a 'gateway cognition', a key psychological motivator causally influencing personal beliefs about the reality of ACC and related attitudes, such as support for climate mitigation policies. There is some empirical support for this model, with experiments showing that information about the scientific consensus on climate change can increase belief in ACC and that this effect is mediated by perception of scientific consensus (e.g. Brewer & McKnight, 2017; Kerr & Wilson, 2018; Lewandowsky, Gignac, & Vaughan, 2012; van der Linden, Leiserowitz, & Maibach, 2016). However, some studies have also reported that interventions which significantly increase perceptions of scientific agreement on climate change have no overall impact on personal beliefs (Dixon, Hmielowski, & Ma, 2017; van der Linden, Leiserowitz, Feinberg, & Maibach, 2014). In light of such results, a number of researchers have called for further research examining the causal direction of the relationship between perceived consensus and scientific beliefs (Bolsen & Druckman, 2018; Kohl et al., 2016; National Academies of Sciences, Engineering, and Medicine, 2016; Pasek, 2017). If perceived consensus does not influence personal beliefs, what could explain the association between the two? It is possible that personal beliefs are casually prior to perceptions of consensus. Motivated reasoning (Kunda, 1990), biased perceptions of expertise (Kahan, Jenkins-Smith, & Braman, 2011) and selective media exposure (Hart et al., 2009) could all skew perceptions of the scientific

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https://doi.org/10.1016/j.jenvp.2018.08.012
Received 15 February 2018; Received in revised form 28 August 2018; Accepted 28 August 2018
Available online 29 August 2018
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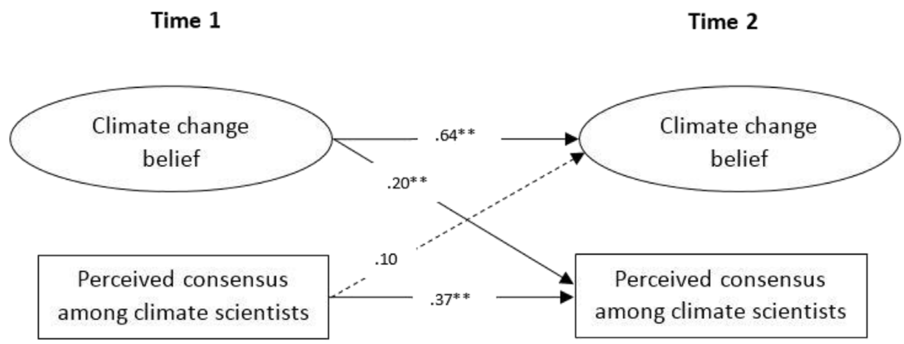

Fig. 1. Standardized associations between personal beliefs and perceptions of consensus over time regarding the reality of ACC. $^{**}p < .01$. Solid lines represent significant paths, and dotted lines represent non-significant paths.

agreement to fit one's own beliefs. Finally, we must note that the two paths of influence are not mutually exclusive; it is possible that a bi-directional relationship exists between perceptions of consensus and personal beliefs.

Longitudinal analysis is one method which allows potential causal inferences to be made about the relationships between variables (Finkel, 1995; Selig & Little, 2012). Autoregressive cross-lagged panel analysis examines the relationships between two or more variables across two or more time points. Although such analyses do not provide absolute 'proof' of causality, they can be a useful tool in making casual inferences given the temporal precedence of independent variables over the dependent variables. As Selig and Little (2012) note, results from panel analyses can be "used in conjunction with theory and other empirical results as one element in a larger argument in favor of a causal relationship" (p. 276).

To this end, we examine the relationship between perceptions of a scientific consensus and personal beliefs about ACC at two time points, approximately five months apart. Our first hypothesis (H1) is that self-reported beliefs and perceptions of consensus (operationalised as an estimate of the percentage of scientists in agreement with a given proposition) on this issue will be correlated at each time point, replicating the findings of previous cross-sectional research (Hornsey et al., 2016). The causal path outlined by the gateway belief model (van der Linden et al., 2015) posits that perceptions of consensus causally influence personal agreement with the consensus. Following the model, we hypothesise (H2) that perceived consensus will prospectively predict personal agreement with the scientific consensus at a later time point.

2. Method

2.1. Participants

Students undertaking consecutive first-year psychology courses at Victoria University Wellington in 2014 completed two online surveys five months apart as part of a research participation requirement (N = 356; 21.6% male; mean age 18.64, *SD* = 2.15). Only students who completed both surveys were included in analyses. Participants gave informed consent and the study was approved by the Victoria University of Wellington School of Psychology Human Ethics Committee.

2.2. Measures

Belief in ACC was measured using a reliable four-item scale from) (example: 'Burning of fossil fuels on the scale observed over the last 50 years has increased atmospheric temperature to an appreciable degree'; Cronbach's α: Time 1 = 0.83; Time 2 = 0.87). Responses were captured on a seven-point Likert scale (from 1 = *strongly disagree* to 7 = *strongly agree*). Participants also provided estimates of the scientific consensus regarding ACC, captured by a single item: 'Out of 100 climate scientists how many do you think believe that human CO2 emissions cause climate change?' Participants entered a number between 0 and 100. As political orientation has been shown to be a predictor of ACC (Hornsey et al., 2016), political orientation was captured by an open-ended question asking participants which political party would vote for, with responses coded liberal or conservative (see supplementary material, Appendix A).

2.3. Analytic procedure

Missing data (less than 1% of values) were imputed using expectation maximization in SPSS version 23.0. A cross-lagged model was constructed using AMOS version 23.0 (Arbuckle, 2014), examining the effect of Time 1 beliefs and consensus estimates on Time 2 beliefs and consensus estimates. For the latent climate belief measure, error terms associated with each item were correlated over time. Standard errors and 95% bias-corrected confidence intervals were estimated using the AMOS bootstrapping procedure (based on 1000 iterations).

3. Results

The means and standard deviations for all variables and zero-order inter-correlations are displayed in Table S2 in the supplementary material (Appendix B). Personal belief in ACC and perceptions of consensus were significantly positively correlated at both Time 1 and Time 2 (r's 0.31 and 0.33, $p < .001$).

The cross-lagged model displayed a good fit to the data (χ^2 (27) = 30.94, $p = .27$; SRMR = 0.021; CFI = 0.998; RMSEA = 0.020, 90% CI [0.000, 0.048]). Time 1 personal belief that ACC is occurring was a significant predictor of change in consensus estimates ($\beta = 0.20$, $p = .002$, 95% CI [0. 08, 0.31]), but Time 1 consensus estimates did *not* predict change in Time 2 belief ($\beta = 0.10$, $p = .084$, 95% CI [-0.02, 0.21]; Fig. 1). Constraining these cross-lagged paths to be equal significantly reduced fit ($\Delta\chi^2 = 12.86$, $p < .001$), indicating the paths are different.

To investigate the possibility that the cross-lagged effects seen in the model are moderated by political orientation, we conducted additional nested models comparing groups defined by party voting preference (see supplementary materials, Appendix C). The effect of Time 1 perceived consensus on Time 2 beliefs was not significant for either liberals ($N = 129$) or conservatives ($N = 119$) ($\beta_{Lib} = 0.06$, $p = .46$, 95% CI [-0. 09, 0.21]; $\beta_{Con} = 0.07$, $p = .41$, 95% CI [-0. 15, 0.28]). The effect of Time 1 beliefs on Time 2 perceptions of consensus did differ between groups; this path was significant for participants with liberal voting intentions but not for those with conservative voting intentions ($\beta_{Lib} = 0.28$, $p > .001$, 95% CI [0. 11, 0.45]; $\beta_{Con} = 0.04$, $p = .66$, 95% CI [-0. 13, 0.23]).

4. Discussion

This study is, to our knowledge, the first to longitudinally examine the relationship between perceptions of consensus and personal beliefs regarding ACC in the absence of experimental manipulations. Consistent with prior research, and our expectations (H1), we found that perceptions of consensus were positively correlated with personal agreement at each time point. Estimates of scientific agreement at Time 1 did not predict personal beliefs at Time 2, thus we did not find support for our second hypothesis (H2) based on the gateway belief model. Additional analyses indicated that this effect was not moderated by party voting preference. Our results do, however, indicate that personal beliefs are a predictor of subsequent perceived consensus; participants' personal agreement with the reality of ACC at Time 1 prospectively predicted their estimates of scientific agreement at Time 2. However, this effect was moderated by political party support, such that personal agreement predicted later perceptions of consensus for liberal participants only. These results suggest that politically liberal individuals may be more likely to base their estimates of the scientific consensus regarding ACC on their own beliefs, rather than formulate their beliefs based on perceived agreement among scientists. This finding is discussed further in the supplementary material (Appendix C).

Our findings conflict with the results of several experimental studies showing that messages highlighting the scientific consensus increase belief in ACC, and that this effect is mediated via perceptions of consensus (e.g. van der Linden et al., 2015, 2016). These studies indicate that in a laboratory environment participants alter their beliefs on the basis of changes in perceived consensus. Experimental research has focused on the effects of exposure to consensus messages with all other variables controlled for and over very short periods (for an exception see Deryugina & Shurchkov, 2016). While these studies suggest that perceptions of consensus are causally prior to climate belief in an experimental setting, the current research indicates, in a more ecologically valid setting, that consensus beliefs do not have a strong influence on personal beliefs over time.

As the first study to examine the cross-lagged effects of perceived consensus and scientific beliefs over time, the current study adds to the growing body of empirical research informing the ongoing debate around efforts to communicate the scientific consensus (Cook, 2017; Kahan & Carpenter, 2017; Kahan, 2015; Oreskes, 2017; Pearce et al., 2017b, 2017a). Acceptance of the reality of climate change is critical to the adoption of actions to mitigate and adapt to future impacts (Gifford, 2011). Drawing on the gateway belief model, some researchers have strongly endorsed the use of messages highlighting the scientific consensus on climate change to increase public acceptance of the phenomenon (Maibach & van der Linden, 2016; van der Linden & Lewandowsky, 2015). However, the current results, along with some recent experimental studies (e.g. Dixon et al., 2017; Kobayashi, 2018) suggest that communication campaigns seeking to increase perceptions of scientific consensus may not always have a significant effect on personal beliefs regarding ACC. Scientists, journalists and policy-makers should not simply rely solely on highlighting the expert consensus as a means to increase public acceptance of ACC. On the basis of the current preliminary research, we are hesitant to conclude that consensus messaging is totally ineffective, but encourage further longitudinal or field studies (Kahan & Carpenter, 2017) with larger, more representative samples to confirm the generalisability of these findings. Researchers should also continue to explore a variety of approaches for increasing acceptance of the reality of ACC.

A key limitation of this study is the use of a student sample comprised mostly of young adults who may differ from the general public in terms of their beliefs about ACC (Milfont, Milojev, Greaves, & Sibley, 2015) and openness to changing attitudes (Krosnick & Alwin, 1989). This research was undertaken in a New Zealand sample which may differ from the predominantly US samples in related studies (e.g. van der Linden et al., 2015). Although New Zealand exhibits relatively high levels of climate scepticism, climate change is less of a partisan political issue in New Zealand compared to the US (Hornsey, Harris, & Fielding, 2018; Tranter & Booth, 2015). Therefore, findings regarding the moderation of paths by political orientation may be different in contexts such as the US where climate change is a more politically divisive issue. The use of a single item measure to capture perceptions of consensus is a further limitation. Although variations of this single-item measure are commonly used in research examining perceptions of consensus (e.g. Lewandowsky et al., 2012; van der Linden et al., 2015) it may have introduced measurement error into our model.

In summary, this longitudinal study captured students' agreement that ACC is occurring and their perception of agreement among the scientific community at two time points. Our analysis did not find evidence that perceptions of scientific consensus prospectively predict later personal beliefs regarding the reality of ACC, as would be predicted by the gateway belief model.

Declarations of interest

None.

Funding

This research was not supported by grant funding from any funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jenvp.2018.08.012.

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